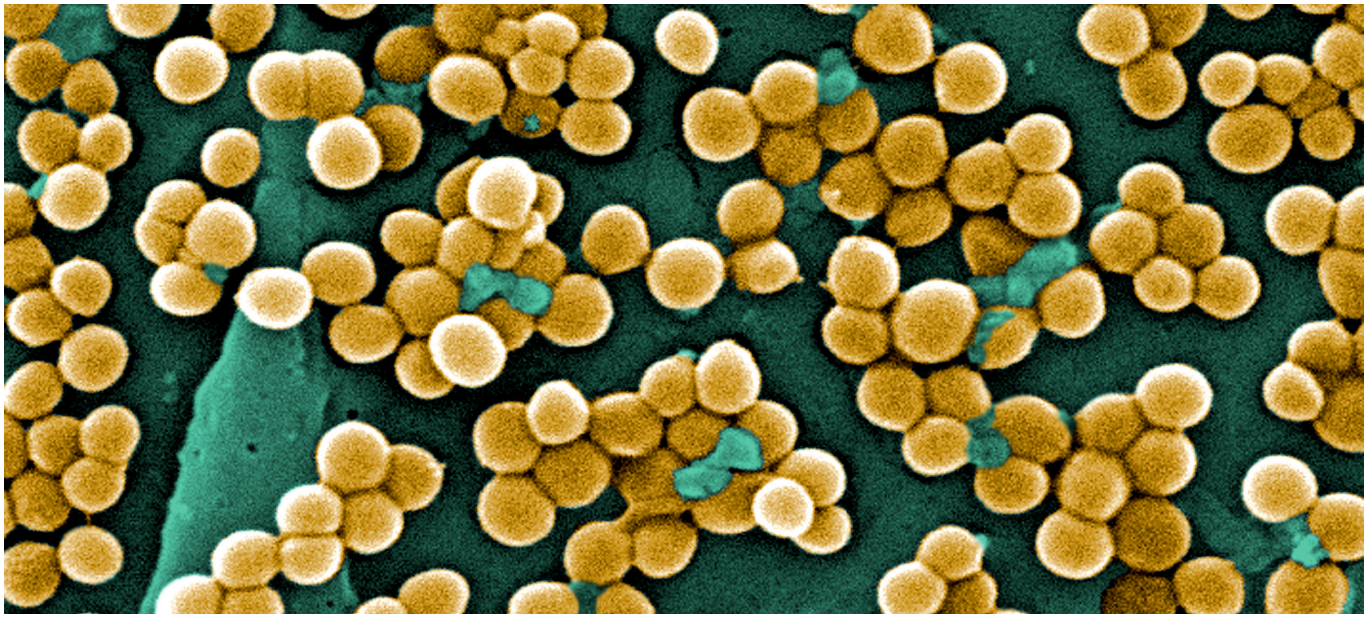
THE JAMES MARTIN
21ST CENTURY SCHOOL
UNIVERSITY OF OXFORD

A NOVEL APPROACH TO ANTIBIOTIC RESISTANCE

NANOSCALE DRUG DELIVERY SYSTEM COULD SOLVE THE PRESSING PROBLEM OF DRUG RESISTANT BACTERIA



Clumps of methicillin-resistant Staphylococcus aureus bacteria (MRSA); Magnified 9560x.
Source: Janice Haney Carr, Centers for Disease Control and Prevention

At the beginning of the 21st century, antibiotic resistance is one of the world's most pressing public healthcare problems. In recent decades, almost every variant of bacteria has become stronger and less vulnerable to antibiotic treatment, threatening new strains of infectious disease or super-strains that are both more expensive to treat and more difficult to cure. In response, researchers at the Institute of Nanoscience for Medicine are developing nanoparticle based treatments, to which bacteria will be incapable of developing resistance.

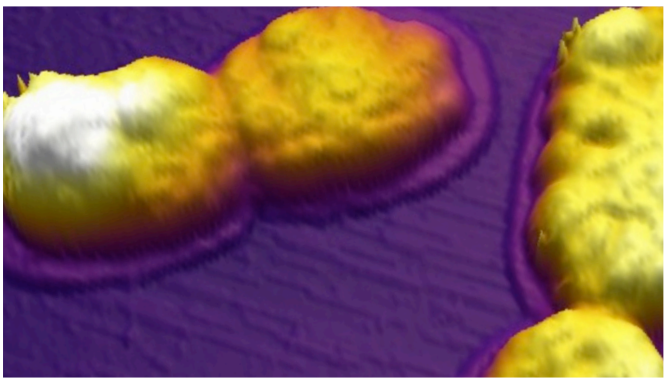
ANTIBIOTIC RESISTANCE

When antibiotics are used incorrectly, the likelihood that bacteria will adapt, developing resistance, is greatly enhanced. Bacteria are particularly efficient at enhancing the effects of resistance, not only because of their ability to multiply very rapidly but also because bacteria can pass information to each other through 'plasmid exchange', whereby plasmids carrying resistant genes jump from one bacteria to another. Resistance to a single drug can thus spread rapidly through a bacterial population, leading to an increasing prevalence of dangerous multi-drug resistant infections.

Recent evidence suggests that an antibiotic formulation in the form of nanoparticles could be a highly effective bactericidal material. This would provide a solution to the increasingly urgent problem of antibiotic resistance, reducing the risk from infections and related complications, which take a heavy toll on already vulnerable hospital patients.

A POTENTIAL SOLUTION

James Martin Fellow Dr Sonia Trigueros and Co-Director Dr Sonia Contera, senior researchers in the Institute of Nanoscience for Medicine, are currently developing a targeted drug delivery system (using nanostructures to deposit drugs within specific cells) which they believe could be put to use as an antibacterial treatment. This approach relies on the fact that, while bacteria are very well adapted to meeting the challenges faced by current antibiotics, the larger, metallic nanostructures would be an alien concept which bacteria could not recognise as a threat. These nanostructures should therefore be capable of depositing drugs within individual bacteria cells – thus bypassing the problem of resistance.



Atomic force microscopic image of bacteria (E. Coli) during cell division
Source: Contera and Trigueros, unpublished

A nanoscale approach could offer further advantages over traditional antibiotics, as nanostructures could be programmed to act more precisely. One exciting possibility is the idea of designing treatments capable of distinguishing between 'good' and 'bad' bacteria.

CHALLENGES

In order to achieve these ambitious goals, research at the Institute of Nanoscience for Medicine is focused on improving capabilities in the following areas:

- Imaging: improving on current imaging mechanisms in order to model more accurately the interaction between nanostructures and cells
- Targeting: developing nanoscale mechanisms capable of targeting specific cells within the human body
- Delivery: creating nanostructures capable of transporting drugs across cell membranes before release
- Coatings: coating these nanostructures with a range of antibacterial drugs
- Toxicity: ensuring that the treatment will only damage bacterial cells

LOOKING TO THE FUTURE

Finding a solution to the problem of antibiotic resistance is an urgent global healthcare priority. Life threatening infections such as MRSA, tuberculosis and E. coli are all developing resistance to commonly prescribed antibiotics and very few new antibiotics are currently under development. Overcoming the ability of bacteria to develop resistance could potentially prevent thousands of needless deaths per year in the UK alone, and reduce the burden on healthcare systems around the world.

Nanoscience is a relatively new field of research, yet our growing ability to build at the molecular level allows for the creation of customised structures which have the potential to transform medicine. It is hoped that this project will enable the development of an urgently needed new generation of antibiotic treatments.

INSTITUTE OF NANOSCIENCE FOR MEDICINE

Combining expertise in physics, biology and computer modelling, the Institute of Nanoscience for Medicine was launched in 2008 to investigate possible medical applications of nanotechnology. The Institute seeks to improve our understanding of how nanostructures interact with DNA, proteins, membranes and, ultimately, with cells. The aim is to help establish fundamental design principles for nanoscale drug delivery methods and enhance understanding of potential nano-toxicological effects.

For more information on the work of the Institute of Nanoscience for Medicine, go to:
http://nanomed.bioch.ox.ac.uk

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For more information about the 21st Century School and its work on the challenges of the future visit:
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